WHAT IS CLAIMED IS:

1. An optical fiber comprising a core region extending along a predetermined axis, and a cladding region surrounding the core region;

the cladding region having first to (N+1)-th regions (where N is an integer of 2 or greater) such that the first region surrounds the core region, and the (k+1)-th region surrounds the k-th region (k=1,2,...,N);

at least one of the first to (N+1)-th regions including, in a main medium having a predetermined refractive index, a sub-region made of an auxiliary medium having a refractive index different from that of the main medium;

letting n[0] be the average refractive index of the core region, and n[k] (k = 1, 2, ..., N+1) be the average refractive index of the k-th region, the optical fiber satisfying the relationship of $n[0] > n[1]$, and $n[i] > n[i+1]$ ($\forall i = h, h+1, \ldots, h+m$; where h and m are natural numbers).

2. An optical fiber according to claim 1, satisfying the relationship of

$n[i] > n[i+1]$ ($\forall i = 0, 1, \ldots, N$).

3. An optical fiber according to claim 2, wherein the cladding region further has an (N+2)-th region surrounding the (N+1)-th region; and

wherein the (N+2)-th and (N+1)-th regions include respective average refractive indices n[N+2] and n[N+1] satisfying the relationship of

$n[N+1] < n[N+2]$.

4. An optical fiber according to claim 2, wherein the main medium is pure silica glass, or silica glass including at least one of Ge, F, Cl, P, N, B, Al, Ti, Er, Yb, Nd, Pr, and Bi; and wherein the auxiliary medium is a vacuum or gas.

5. An optical fiber according to claim 2, exhibiting a dispersion nonflatness of 0.003 $ps/nm^2/km$ or less at zero dispersion in a predetermined wavelength band having a width of at least 50 nm.

6. An optical fiber according to claim 2, exhibiting a dispersion nonflatness of 0.004 $ps/nm^2/km$ or less in a predetermined wavelength band having a width of at least 50 nm; and wherein a chromatic dispersion in the predetermined wavelength band is an anomalous dispersion having an average value of +20 ps/nm/km or less.

7. An optical fiber according to claim 2, exhibiting a dispersion nonflatness of 0.006 $ps/nm^2/km$ or less in a predetermined wavelength band having a width of at least 50 nm; and wherein a chromatic dispersion in the predetermined wavelength band is a normal dispersion having an average value of -20 ps/nm/km or less.

8. An optical fiber according to claim 2, wherein a cross-sectional area of the sub-region made of the auxiliary medium in a cross section perpendicular to the predetermined axis varies along the predetermined axis.

9. An optical fiber according to claim 8, comprising:

a first category fiber segment exhibiting a dispersion nonflatness of 0.007 ps/nm^2/km or less in a predetermined wavelength band having a width of at least 50 nm, and having an anomalous chromatic dispersion with an average value of +1 ps/nm/km or greater in the predetermined wavelength band; and

a second category fiber segment exhibiting a dispersion nonflatness of 0.007 ps/nm^2/km or less in the predetermined wavelength band, and having a normal chromatic dispersion with an average value of -1 ps/nm/km or less in the predetermined wavelength band.

10. An optical fiber according to claim 8, comprising a fiber segment having one end and the other end; wherein the fiber segment exhibits a dispersion nonflatness of 0.007 ps/nm^2/km or less in a predetermined wavelength band having a width of at least 50 nm; wherein a chromatic dispersion at a predetermined wavelength at the one end is an anomalous dispersion of +1 ps/nm/km or greater; wherein the chromatic dispersion continuously decreases from the one end to the other end; and wherein the other end exhibits a chromatic dispersion not greater than half of that at the one end at the predetermined wavelength.

11. An optical fiber according to claim 2, wherein, letting $D(\lambda)$ be the chromatic dispersion with respect to

each wavelength λ included within a predetermined wavelength band having a width of at least 250 nm, and $F(\lambda)$ be the function defined by

$$F(\lambda) = a\lambda^{-4} + b\lambda^{-2} + c + d\lambda^{2} + e\lambda^{4}$$

$a = -24.495$ [ps/nm/km/μm^{-4}]

$b = -54.564$ [ps/nm/km/μm^{-2}]

$c = 35.069$ [ps/nm/km]

$d = 1.8867$ [ps/nm/km/μm^{2}]

$e = 0.80887$ [ps/nm/km/μm^{4}],

a function $G(\lambda, x)$ is defined as

$$G(\lambda, x) = |(F(\lambda) + xD(\lambda))/(1 + x)|, \text{ and}$$

the optical fiber gives a positive number x satisfying the relationship of $G(\lambda, x) < 0.25$ [ps/nm/km].

12. An optical fiber according to claim 1, satisfying the relationship of

$n[0] > n[1]$, $n[1] < n[2]$, and $n[i] > n[i+1]$ ($\forall i = 2, 3, \ldots, 2+m$; where m is a natural number).

13. An optical fiber according to claim 12, wherein, letting $D(\lambda)$ be the chromatic dispersion with respect to each wavelength λ included within a predetermined wavelength band having a width of at least 250 nm, and $F(\lambda)$ be the function defined by

$$F(\lambda) = a\lambda^{-4} + b\lambda^{-2} + c + d\lambda^{2} + e\lambda^{4}$$

$a = -24.495$ [ps/nm/km/μm^{-4}]

$b = -54.564$ [ps/nm/km/μm^{-2}]

$c = 35.069$ [ps/nm/km]

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$e = 0.80887$ [ps/nm/km/μm^4],

a function $G(\lambda, x)$ is defined as

$G(\lambda, x) = |(F(\lambda) + xD(\lambda))/(1 + x)|$, and

the optical fiber gives a positive number x satisfying the relationship of $G(\lambda, x) < 0.25$ [ps/nm/km].

14. An optical fiber comprising a core region extending along a predetermined axis, and a cladding region surrounding the core region;

the optical fiber exhibiting a dispersion nonflatness of 0.003 ps/nm^2/km or less at zero dispersion in a predetermined wavelength band having a width of at least 50 nm.

15. An optical fiber comprising a core region extending along a predetermined axis, and a cladding region surrounding the core region;

the optical fiber exhibiting a dispersion nonflatness of 0.004 ps/nm^2/km or less in a predetermined wavelength band having a width of at least 50 nm, a chromatic dispersion in the predetermined wavelength band being an anomalous dispersion having an average value of +20 ps/nm/km or less.

16. An optical fiber comprising a core region extending along a predetermined axis, and a cladding region surrounding the core region;

the optical fiber exhibiting a dispersion nonflatness of 0.006 ps/nm^2/km or less in a predetermined wavelength

band having a width of at least 50 nm, a chromatic dispersion in the predetermined wavelength band being a normal dispersion having an average value of -20 ps/nm/km or greater.

17. An optical fiber comprising a core region extending along a predetermined axis, and a cladding region surrounding the core region;

the optical fiber including:

a first category fiber segment exhibiting a dispersion nonflatness of 0.007 ps/nm^2/km or less in a predetermined wavelength band having a width of at least 50 nm, and having an anomalous chromatic dispersion with an average value of +1 ps/nm/km or greater in the predetermined wavelength band; and

a second category fiber segment exhibiting a dispersion nonflatness of 0.007 ps/nm^2/km or less in the predetermined wavelength band, and having a normal chromatic dispersion with an average value of -1 ps/nm/km or less in the predetermined wavelength band.

18. An optical fiber comprising a core region extending along a predetermined axis, and a cladding region surrounding the core region;

wherein the optical fiber includes a fiber segment having one end and the other end; wherein the fiber segment exhibits a dispersion nonflatness of 0.007 ps/nm^2/km or less in a predetermined wavelength band having a width of at least

50 nm; wherein a chromatic dispersion at a predetermined wavelength at the one end is an anomalous dispersion of +1 ps/nm/km or greater; wherein the chromatic dispersion continuously decreases from the one end to the other end; and wherein the other end exhibits a chromatic dispersion not greater than half of that at the one end at the predetermined wavelength.

19. An optical fiber comprising a core region extending along a predetermined axis, and a cladding region surrounding the core region;

wherein, letting $D(\lambda)$ be the chromatic dispersion with respect to each wavelength λ included within a predetermined wavelength band having a width of at least 250 nm, and $F(\lambda)$ be the function defined by

$$F(\lambda) = a\lambda^{-4} + b\lambda^{-2} + c + d\lambda^{2} + e\lambda^{4}$$

$a = -24.495$ [ps/nm/km/μm^{-4}]

$b = -54.564$ [ps/nm/km/μm^{-2}]

$c = 35.069$ [ps/nm/km]

$d = 1.8867$ [ps/nm/km/μm^{2}]

$e = 0.80887$ [ps/nm/km/μm^{4}],

a function $G(\lambda, x)$ is defined as

$$G(\lambda, x) = |(F(\lambda) + xD(\lambda))/(1 + x)|, \text{ and}$$

the optical fiber gives a positive number x satisfying the relationship of $G(\lambda, x) < 0.25$ [ps/nm/km].

20. An optical fiber according to claim 1, wherein, letting T[N+1] μm be the radial thickness of the (N+1)-th

region, the optical fiber satisfies the relationship of

$$T[N+1]\cdot\sqrt{n[0]^2-n[N+1]^2}>1.0.$$

21. An optical fiber according to claim 2, wherein, letting T[N+1] μm be the radial thickness of the (N+1)-th region, the optical fiber satisfies the relationship of

$$T[N+1]\cdot\sqrt{n[0]^2-n[N+1]^2}>1.0.$$

22. An optical fiber according to claim 12, wherein, letting T[N+1] μm be the radial thickness of the (N+1)-th region, the optical fiber satisfies the relationship of

$$T[N+1]\cdot\sqrt{n[0]^2-n[N+1]^2}>1.0.$$

23. An optical fiber according to claim 5, exhibiting a transmission loss of 0.1 dB/m or less in the predetermined wavelength band.

24. An optical fiber according to claim 6, exhibiting a transmission loss of 0.1 dB/m or less in the predetermined wavelength band.

25. An optical fiber according to claim 7, exhibiting a transmission loss of 0.1 dB/m or less in the predetermined wavelength band.

26. An optical fiber according to claim 11, exhibiting a transmission loss of 0.1 dB/m or less in the predetermined wavelength band.

27. An optical fiber according to claim 14, exhibiting a transmission loss of 0.1 dB/m or less in the predetermined wavelength band.

28. An optical fiber according to claim 15,

exhibiting a transmission loss of 0.1 dB/m or less in the predetermined wavelength band.

29. An optical fiber according to claim 16, exhibiting a transmission loss of 0.1 dB/m or less in the predetermined wavelength band.

30. An optical fiber according to claim 19, exhibiting a transmission loss of 0.1 dB/m or less in the predetermined wavelength band.

31. An optical fiber according to claim 13, exhibiting a transmission loss of 3 dB/m or less in the predetermined wavelength band.

32. An optical fiber according to claim 1, wherein the sub-region made of the auxiliary medium included in the first to (N+1)-th regions is arranged in a hexagonal form in a cross section perpendicular to the predetermined axis.

33. An optical fiber comprising a core region extending along a predetermined axis, and a cladding region surrounding the core region;

the cladding region having at least three layers continuing to a radially outside, the three layers including inner, intermediate, and outer layers toward the radially outside;

at least one of the layers including, in a main medium having a predetermined refractive index, a sub-region made of an auxiliary medium having a refractive index different from that of the main medium;

the intermediate layer exhibiting an average refractive index lower than that of the inner layer, the outer layer exhibiting an average refractive index lower than that of the intermediate layer.

5